

ENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 243513-PCT	FOR FURTHER ACTION		see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/ZA 00/ 00024	International filing date (day/month/year) 11/02/2000	(Earliest) Priority Date (day/month/year) 11/02/1999	
Applicant STEINER, Philipp, Daniel			

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of Invention is lacking** (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawing to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

☒ **None** of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/ZA 00/00024

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07D307/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 31 39 188 C (H. KNAUTH) 28 July 1983 (1983-07-28) claims 1,2	1-13
A	WO 81 00407 A (BERTIN & CIE.) 19 February 1981 (1981-02-19) claims 1-30	1-13
A	DE 38 42 825 A (FRIEDR. KRUPP GMBH) 20 July 1989 (1989-07-20) claims 1-10	1-13
A	US 4 533 743 A (D. J. MEDEIROS, M. B. BURNETT) 6 August 1985 (1985-08-06) claims 1-13	1-6
	--- -/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

27 June 2000

Date of mailing of the international search report

06/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Herz, C

INTERNATIONAL SEARCH REPORT

International Application No

PCT/ZA 00/00024

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 346 836 A (JEDNOTE ZEMEDELSE DRUZSTVO JANA CERNEHO SE SIDLEM) 20 December 1989 (1989-12-20) claims 1-11 ---	1-13
A	WO 96 25553 A (F + S MARKET, SPOL. S.R.O.) 22 August 1996 (1996-08-22) claims 1-14 ---	1-13
A	US 4 029 515 A (K. KIMINKI ET AL.) 14 June 1977 (1977-06-14) claims 1-7 ---	1-13
A	DATABASE WPI Week 8648 Derwent Publications Ltd., London, GB; AN 1986-317829 XP002141089 & SU 1 225 841 A (KRASD. POLY.), 23 April 1986 (1986-04-23) abstract -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No


PCT/ZA 00/00024

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 3139188	C	28-07-1983	NONE	
WO 8100407	A	19-02-1981	FR 2462433 A BR 8008782 A DE 3068793 D EP 0033323 A HU 185421 B IN 153609 A JP 56501046 T SU 1176840 A US 4366322 A	13-02-1981 26-05-1981 06-09-1984 12-08-1981 28-02-1985 28-07-1984 30-07-1981 30-08-1985 28-12-1982
DE 3842825	A	20-07-1989	CH 678183 A FI 886014 A US 4912237 A ZA 8900080 A	15-08-1991 09-07-1989 27-03-1990 25-10-1989
US 4533743	A	06-08-1985	NONE	
EP 346836	A	20-12-1989	CS 8804060 A DK 289889 A FI 892888 A HU 50802 A	14-11-1990 14-12-1989 14-12-1989 28-03-1990
WO 9625553	A	22-08-1996	CZ 9500320 A AU 4480596 A	14-08-1996 04-09-1996
US 4029515	A	14-06-1977	FI 291174 A CA 1051884 A CS 191945 B DD 124873 A DE 2541119 A FR 2286853 A HU 170628 B IT 1043052 B NO 753114 A, B, SE 425508 B SE 7510297 A SU 652902 A	05-04-1976 03-04-1979 31-07-1979 16-03-1977 08-04-1976 30-04-1976 28-07-1977 20-02-1980 06-04-1976 04-10-1982 05-04-1976 15-03-1979
SU 1225841	A	23-04-1986	NONE	

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 243513		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/ZA00/00024	International filing date (day/month/year) 11/02/2000	Priority date (day/month/year) 11/02/1999	
International Patent Classification (IPC) or national classification and IPC C07D307/50			
Applicant STEINER, Philipp, Daniel et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 4 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input checked="" type="checkbox"/> Certain observations on the international application 			
Date of submission of the demand 08/09/2000		Date of completion of this report 25.05.2001	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer Herz, C Telephone No. +49 89 2399 8275	



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/ZA00/00024

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-13 as originally filed

Drawings, sheets:

1-2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/ZA00/00024

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-13
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-13
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-13
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/ZA00/00024

1. Due to the specific process steps and parameters the claimed process for the production of furfural is considered to be novel vis-à-vis the state of the art as represented by the documents cited in the International Search Report.

Vis-à-vis this state of the art an inventive step can be acknowledged since, for the process claimed, the parameters and conditions as well as its yield in the order of 100% have not been obvious to a person skilled in the art.

2. The use of the terms "a... **predetermined** temperature" and "a **gradual** reduction of pressure" in Claim 1 without further definitive qualification therein renders this claim obscure in scope in that it does not indicate any specific values. The claims shall define the matter for which protection is sought and therefore the meaning of the terms of a claim should, as far as possible, be clear for the person skilled in the art and not throw doubt on the extent of protection (Article 6 PCT). However, the amendments to Claim 1 as proposed in Applicant's letter dated 13/03/01 could be regarded as sufficiently clear in defining the terms objected to.

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 03 November 2000 (03.11.00)	
International application No. PCT/ZA00/00024	Applicant's or agent's file reference 243513-PCT
International filing date (day/month/year) 11 February 2000 (11.02.00)	Priority date (day/month/year) 11 February 1999 (11.02.99)
Applicant ZEITSCH, Karl, J.	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

08 September 2000 (08.09.00)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Maria Kirchner Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

MORRISON, Ian
Ian Morrison Forster & Company
FMI House, Gleneagles Park
Flanders Drive, Mount Edgecombe
P.O. Box 2004
4300 Kwa Zulu Natal
AFRIQUE DU SUD

Date of mailing (day/month/year) 14 August 2001 (14.08.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 243513-PCT	
International application No. PCT/ZA00/00024	International filing date (day/month/year) 11 February 2000 (11.02.00)

1. The following indications appeared on record concerning:		
<input checked="" type="checkbox"/> the applicant	<input type="checkbox"/> the inventor	<input type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address STEINER, Philipp Daniel and ZEITSCH, Karl, J.	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input type="checkbox"/> the person	<input type="checkbox"/> the name	<input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address INTERNATIONAL FURAN TECHNOLOGY (PTY) LIMITED 5B New Era House 6 Joseph Avenue Glen Anil 4051 Kwa Zulu Natal South Africa	State of Nationality ZA	State of Residence ZA
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary: Assignment from the applicants in box 1 to the applicant in box 2. The applicants in box 1 remain as applicants for the US only.		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland		Authorized officer V. Gross (Fax 338.87.40)
Facs No.: (41-22) 740.14.35		Telephone No.: (41-22) 338.83.38

PCT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

MORRISON, Ian
Ian Morrison Forster & Company
FMI House, Gleneagles Park
Flanders Drive, Mount Edgecombe
P.O. Box 2004
4300 Kwa Zulu Natal
AFRIQUE DU SUD

Date of mailing (day/month/year) 08 January 2001 (08.01.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 243513-PCT	
International application No. PCT/ZA00/00024	International filing date (day/month/year) 11 February 2000 (11.02.00)

1. The following indications appeared on record concerning:	
<input checked="" type="checkbox"/> the applicant	<input type="checkbox"/> the inventor <input type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address STEINER, Philipp, Daniel Fleur de Lys Everton Road Kloof 3600 Zwa Zulu Natal South Africa	State of Nationality ZA
	State of Residence ZA
	Telephone No.
	Facsimile No.
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:	
<input type="checkbox"/> the person <input type="checkbox"/> the name <input checked="" type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence	
Name and Address STEINER, Philipp, Daniel Fleur de Lys Everton Road Kloof 3600 Kwa Zulu Natal South Africa	State of Nationality ZA
	State of Residence ZA
	Telephone No.
	Facsimile No.
3. Further observations, if necessary:	
4. A copy of this notification has been sent to:	
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Sean Taylor Telephone No.: (41-22) 338.83.38
--	---



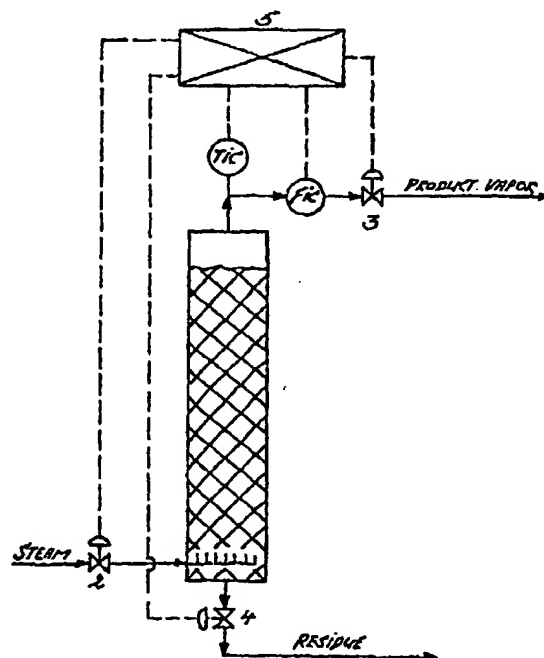
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : C07D 307/50		A1	(11) International Publication Number: WO 00/47569
			(43) International Publication Date: 17 August 2000 (17.08.00)
(21) International Application Number: PCT/ZA00/00024 (22) International Filing Date: 11 February 2000 (11.02.00) (30) Priority Data: 199 05 655.2 11 February 1999 (11.02.99) DE (71) Applicant (for all designated States except US): STEINER, Philipp, Daniel [ZA/ZA]; Fleur de Lys, Everton Road, Kloof, 3600 Zwa Zulu Natal (ZA). (72) Inventor; and (75) Inventor/Applicant (for US only): ZEITSCH, Karl, J. [DE/DE]; Dürener Strasse 393, D-50935 Köln (DE). (74) Agents: MORRISON, Ian et al.; Ian Morrison Forster & Company, FMI House, Gleneagles Park, Flanders Drive, Mount Edgecombe, P.O. Box 2004, 4300 Kwa Zulu Natal (ZA).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	

(54) Title: PROCESS FOR THE MANUFACTURE OF FURFURAL

(57) Abstract

In a new process for the manufacture of furfural, a "pentosan-containing raw material acidified or not, is heated to a temperature T_1 by admitting steam through valve 2 while the valves 3 and 4 are closed. During the very short heating process, the steam condenses, thus increasing the moisture content of the charge. Then, valve 2 is closed and a leak valve 3 is opened so as to produce a steady small flow of product vapour by gradual depressurisation. This causes a slow drop in temperature. When in this fashion a suitably chosen temperature T_2 is reached, the leak valve 3 is closed to terminate the first "gradual depressurisation". If at the end of this period no more furfural was obtained, the digestion is completed by opening valve 4 to discharge the residue. If, however, furfural was still obtained, the reactor is reheated and submitted to another "gradual depressurisation" period.



Schematic of the delayed decompression process for the production of furfural.

PCT

REC'D 29 MAY 2001

WIPO

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)


Applicant's or agent's file reference 243513	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/ZA00/00024	International filing date (day/month/year) 11/02/2000	Priority date (day/month/year) 11/02/1999
International Patent Classification (IPC) or national classification and IPC C07D307/50		
Applicant STEINER, Philipp, Daniel-et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
 - ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 08/09/2000	Date of completion of this report 25.05.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Herz, C Telephone No. +49 89 2399 8275



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/ZA00/00024

I. Basis of this report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-13 as originally filed

Drawings, sheets:

1-2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/ZA00/00024

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-13
	No: Claims
Inventive step (IS)	Yes: Claims 1-13
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-13
	No: Claims

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/ZA00/00024

1. Due to the specific process steps and parameters the claimed process for the production of furfural is considered to be novel vis-à-vis the state of the art as represented by the documents cited in the International Search Report.

Vis-à-vis this state of the art an inventive step can be acknowledged since, for the process claimed, the parameters and conditions as well as its yield in the order of 100% have not been obvious to a person skilled in the art.

2. The use of the terms "a... **predetermined** temperature" and "a **gradual** reduction of pressure" in Claim 1 without further definitive qualification therein renders this claim obscure in scope in that it does not indicate any specific values. The claims shall define the matter for which protection is sought and therefore the meaning of the terms of a claim should, as far as possible, be clear for the person skilled in the art and not throw doubt on the extent of protection (Article 6 PCT). However, the amendments to Claim 1 as proposed in Applicant's letter dated 13/03/01 could be regarded as sufficiently clear in defining the terms objected to.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
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PROCESS FOR THE MANUFACTURE OF FURFURAL

TECHNICAL FIELD OF THE INVENTION

This invention relates to a process for the manufacture of furfural.

BACKGROUND OF THE INVENTION

5 Chemical reactors must be designed to suit the characteristics of the process intended. In making furfural, this has not been the case. For the first industrial production of furfural, QUAKER OATS used reactors from an abandoned cereal process as they happened to be available, and such reactors have been used ever since. Later, ROSENLEW and ESCHER WYSS built furfural plants based on reactors designed for
10 making wood pulp. None of the industrial furfural reactors employed today were conceived to meet the special requirements of furfural production, and it is, therefore, not surprising that the yields obtained with these reactors do not even exceed 60%.

The principal yield losses are caused by a reaction between furfural and xylose, so that striving for a high yield forbids having furfural and xylose in the same place. All
15 existing furfural reactors violate this requirement. By pointedly eliminating this deficiency, the process here described permits attaining yields in the order of 100%.

In analytical chemistry, the conversion of pentosan or pentose to furfural is used for a quantitative determination of these substances. This is possible as it was shown that in this procedure the furfural yield is a proven 100%. The procedure consists in an
20 atmospheric digestion of pentosan or pentose in 12% aqueous HCl saturated with NaCl. By contrast, in the present industrial furfural processes mentioned above, a pressure reactor is used to submit the raw material to a steam treatment. By condensing, the steam effects heating to a constant temperature, and by passing through the raw material, it entrains furfural produced therefrom. The furfural reaction is catalysed either by added mineral acid
25 or by various carboxylic acids (mainly acetic acid and formic acid) formed from the raw material. As compared to the analytical furfural process, a fundamental difference lies in the fact that in the latter process an appropriate heat input maintains the reaction medium in

a state of boiling, whereas in the industrial processes at any pressure a condensation of steam is thermodynamically incapable of bringing the reaction medium, a pentose solution, to boiling, because of the boiling point elevation caused by the xylose. The difference is illustrated schematically in Figure 1 showing phase diagrams for furfural in an aqueous solution boiling at 110°C (12% HCl saturated with NaCl), and in an aqueous solution boiling at 101°C (xylose solution). If a small furfural concentration ξ is generated in the first system representing the analytical furfural process, this leads to point A lying in the vapour field, which means that any furfural formed in this boiling solution will be instantly transformed to vapour where it cannot react with pentose as the latter is not volatile. Consequently, in this case, loss reactions between furfural and pentose are impossible, which explains the proven yield of 100%.

On the other hand, if a small furfural concentration ξ is generated in the second system, and if this system is heated by condensing steam at atmospheric pressure, this leads to point B lying in the liquid field. Hence, in the present industrial furfural reactors the reaction medium is not brought to boiling, so that the furfural remaining in solution can react with pentose to form furfural pentose, which explains the known high yield losses. The entrainment of furfural vapour by the steam flow does not change this statement to any significant extent, since this entrainment is a slow and inefficient process giving the loss reactions in the liquid phase plenty of time to take place.

As the principal difference between the analytical furfural process of 100% yield and the industrial processes of less than 60% yield lies in the fact that in the first case the reaction medium is boiling while in the second case it is not boiling, it was compelling to create an industrial process in which the reaction medium is maintaining in a state of boiling. In view of the fact that with giant furfural reactors, charged with solids not conducive to being stirred, an indirect energy input by heating the walls can be ruled out, it is the essence of this invention to bring about continuous boiling by a gradual (slow) depressurisation. In this fashion, a uniform boiling down to molecular dimensions is enforced without a need for mixing.

Apart from the poor yields achieved, the present commercial processes available are extremely expensive to operate. This is due to the large quantities of steam required,

typically 30 to 50 tons of steam per ton of furfural produced, and also the lengthy reaction times of between 2 and 5 hours.

It is therefore an object of this invention to provide a manufacturing process which not only produces a greater yield, but also requires a lower input of steam per ton of furfural produced and results in a shorter reaction time.

DISCLOSURE OF THE INVENTION

According to the invention, a process for the manufacture of furfural includes the steps of charging a reactor with a pentosan containing material, acidified or not, heating the charge by introduction of pressurised steam to a first predetermined temperature, closing the steam inlet valve of the reactor and subjecting the charge to a gradual reduction of pressure until a second predetermined temperature is attained, the depressurisation maintaining the liquid phase within the reactor in a constantly boiling state.

In the preferred form rate of depressurisation is sufficient to complete the conversion to furfural before a second predetermined temperature is attained. Also in the preferred form of the invention, the charge is acidified prior to heating.

Also in the preferred form of the invention, the gradual depressurisation comprises the controlled leaking of a stream of vapour from the reactor until the second predetermined temperature is attained.

In one form of the invention, a first depressurisation is followed by a reheating to a temperature at or near the first predetermined temperature, the reheating being followed by a second gradual depressurisation.

Subsequent reheating and depressurisation cycles may also be employed if required.

In one form, steam may be added during depressurisation to increase the reaction temperature and improve yield.

In the preferred form of the invention, the charge material may be in solid or liquid form. Bagasse from sugar cane is a common feed and may be added to the reactor in solid or slurry form. Alternative feeds may include any other pentose-containing material, typical examples being corn cobs, bamboo, wood chips, olive press-cake amongst others.

- 5 Also in the preferred form of the invention the gradual depressurisation takes place in the temperature range between 280° Celsius and 150° Celsius, however the preferred range of operation is between 230° Celsius and 170° Celsius.

- 10 By an appropriate choice of the first and second temperatures, and by appropriate selection of a mineral or organic acid concentration, it is possible, if desired, to complete the process in a single depressurisation period since high temperatures and high acidity result in a short reaction time.

In the preferred form of the invention, phosphoric acid is used as the catalyst.

- 15 An apparatus for use in a process according to the invention comprises a pressure reactor including an inlet for steam under pressure, and an outlet for condensate vapour, the inlet and outlet including one or more valves for controlling the flow rate therethrough.

The outlet includes, after a valve, an orifice plate of predetermined dimensions for assisting in controlling the rate of depressurisation. In this form, the valve and orifice plate may be operated in tandem to obtain a range of depressurisation rates or a flow control valve governed by temperature or pressure can be used.

- 20 In any form of the invention the reactor may be thermally well insulated.

- 25 In an alternative form of the invention the reactor walls are designed to be heated. Also in this form, all valve operations are preferably controlled automatically by a computerised control unit. It has been demonstrated experimentally, on a pilot plant scale, that by maintaining the liquid phase of the reaction medium in a state of boiling throughout the reaction period, the furfural yield obtained is substantially greater than current

commercial processes, and if correctly controlled may approach yields achieved in the analytical furfural process. The Applicant contends further that apart from increasing the yield, the process of the invention is operable at substantially lowered capital and productions costs, for the following reasons:

5 (1), The process of the invention does not use steam for stripping furfural from the mass of feed material as once the reactor is sufficiently heated, the steam inlet is closed. Further steam will only be required briefly if a reheating cycle is employed.

10 (2), As a result of the non-use of steam to strip the furfural, the volume of condensate existing the reactor is significantly reduced and the concentration of furfural therein will be proportionately increased in relation to existing processes. This increased furfural concentration will greatly simplify the primary azeotropic distillation. In special cases, for instance in the application of the furfural as a nematicide, no distillation is needed at all.

15 (3), The product of the invention contains less acetic and formic acid (formed from the raw material) since, after reaching the second predetermined temperature of the decompression, most of these by-products are discharged with the residue. This greatly reduces the loading of the effluent generated by the plant.

DESCRIPTION OF THE INVENTION

20 The process according to the invention is described below with reference to Figure 2 which is a schematic diagram of the process and apparatus.

25 A thermally well insulated reactor 1 charged with raw material acidified or not, is heated to a temperature T_1 by admitting steam through valve 2 while the valves 3 and 4 are closed. During the very short heating process, the steam condenses, thus increasing the moisture content of the charge. Then, valve 2 is closed and a leak valve 3 is opened so as to produce a steady small flow of product vapour by gradual depressurisation. This causes a slow drop in temperature. When in this fashion a suitably chosen temperature T_2 is reached, the leak valve 3 is closed to terminate the first "gradual depressurisation". If at the end of this period no more furfural was obtained, the digestion is completed by opening

valve 4 to discharge the residue. If, however, furfural was still obtained, the reactor is reheated and submitted to another "gradual depressurisation" period. This procedure can be arbitrarily repeated. All valve operations are governed by an automatic control unit 5.

5 By an appropriate choice of the temperatures T_1 and T_2 , and by an appropriate choice of the acid concentration, it is possible, if desired, to complete the process in a single depressurisation period since high temperature and high acidity permit a short reaction time.

Needless to say, designing such an operation is complicated as the furfural reaction takes place over a wide range of temperatures (e.g. from 230°C to 160°C), but once
10 calculated, the practical realisation of the process is extremely simple.

As due to the continuous leak stream the reaction medium is maintained in a state of boiling throughout the reaction period, the furfural yield corresponds to that of the analytical furfural processes by lying in the order of 100%.

CLAIMS:

1. A process for the manufacture of furfural characterised in that the steps of charging a reactor with pentosan containing material, heating the charge by introduction of pressurised steam to a first predetermined temperature closing the inlet valve of the reactor,
5 and subjecting the charge to a gradual reduction of pressure until a second predetermined temperature is attained, the depressurisation being at a rate sufficient to maintain the liquid phase within the reactor in a constantly ebullient state.
2. A process according to claim 1 characterised in that the charge is acidified prior to heating.
- 10 3. A process according to claim 1 characterised in that the rate of depressurisation is sufficient to complete conversion to furfural before the second predetermined temperature is reached.
4. A process according to claim 1 characterised in that the complete conversion to furfural is obtained in more than one depressurisation from the first predetermined
15 temperature to the second predetermined temperature by the addition of steam.
5. A process according to claim 1 characterised in that steam is added during the depressurisation, for a predetermined period.
6. A process according to claim 1 characterised in that the gradual depressurisation comprises the controlled leaking of a stream of vapour from the reaction until the second
20 predetermined temperature is attained.

7. A process according to claim 1 characterised in that the gradual depressurisation takes place in the temperature range between 280° Celsius and 150° Celsius.
8. A process according to claim 7 characterised in that the temperature range of operation is between 230° Celsius and 170° Celsius.
- 5 9. A process according to claim 1 characterised in that phosphoric acid is used as the catalyst.
10. A process according to claim 1 characterised in that acetic acid is used as the added catalyst.
- 10 11. An apparatus for the manufacture of furfural according to the process of claim 1 characterised in that it comprises a pressure reactor including an inlet for steam under pressure comprising one or more valves, and an outlet comprising a flow control valve or the combination of a shut-off valve and an orifice of predetermined dimensions.
12. An apparatus according to claim 11 characterised in that the reactor is thermally well insulated.
- 15 13. An apparatus according to claim 12 characterised in that the wall of the reactor is adapted to be heated and/or heat exchange surfaces are incorporated inside the reactor.

1/2

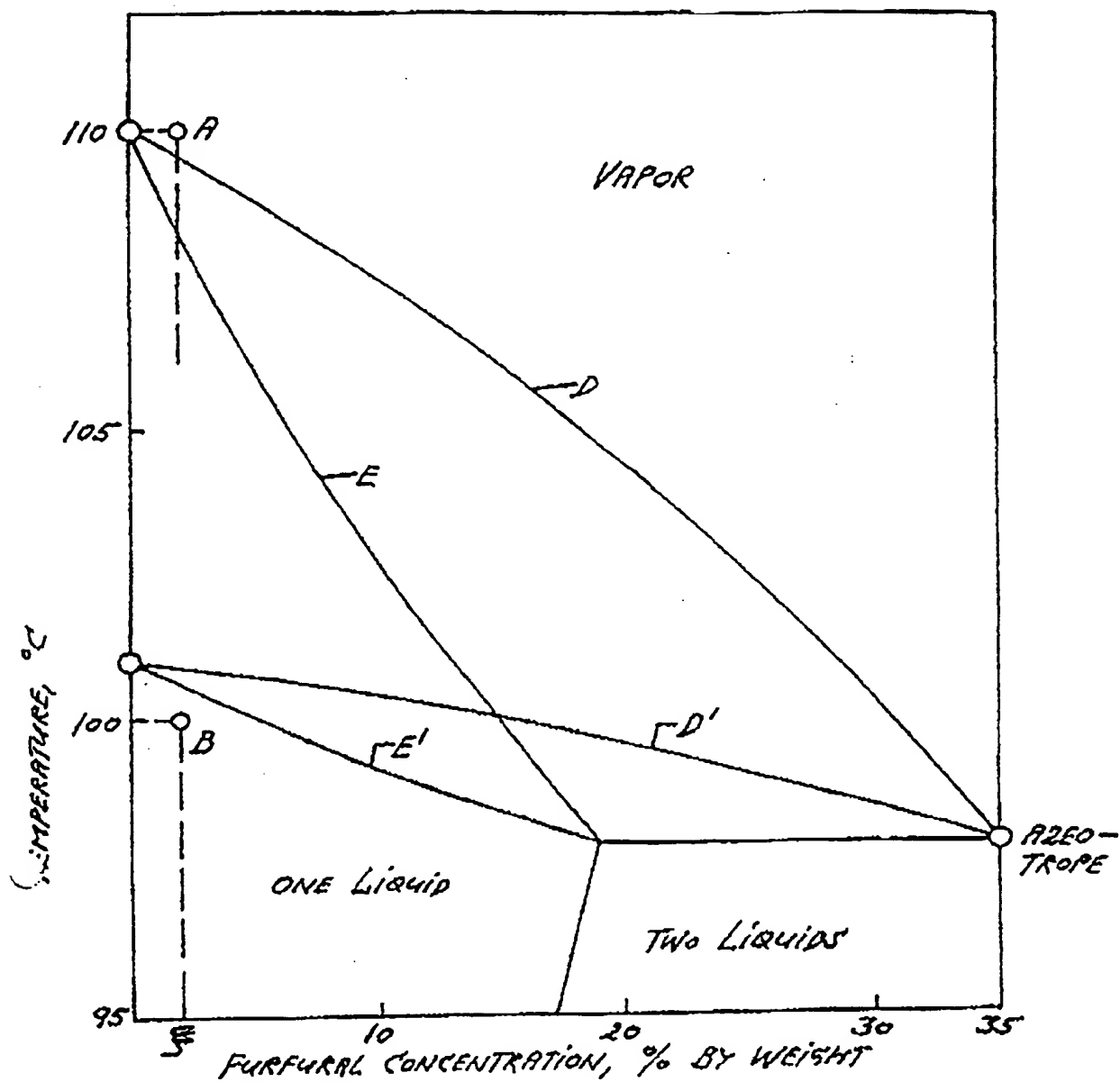


Figure 1. Phase diagram for explaining the difference between analytical and industrial furfural processes.

D and D': Dew point curves

E and E': Boiling point curves

2/2

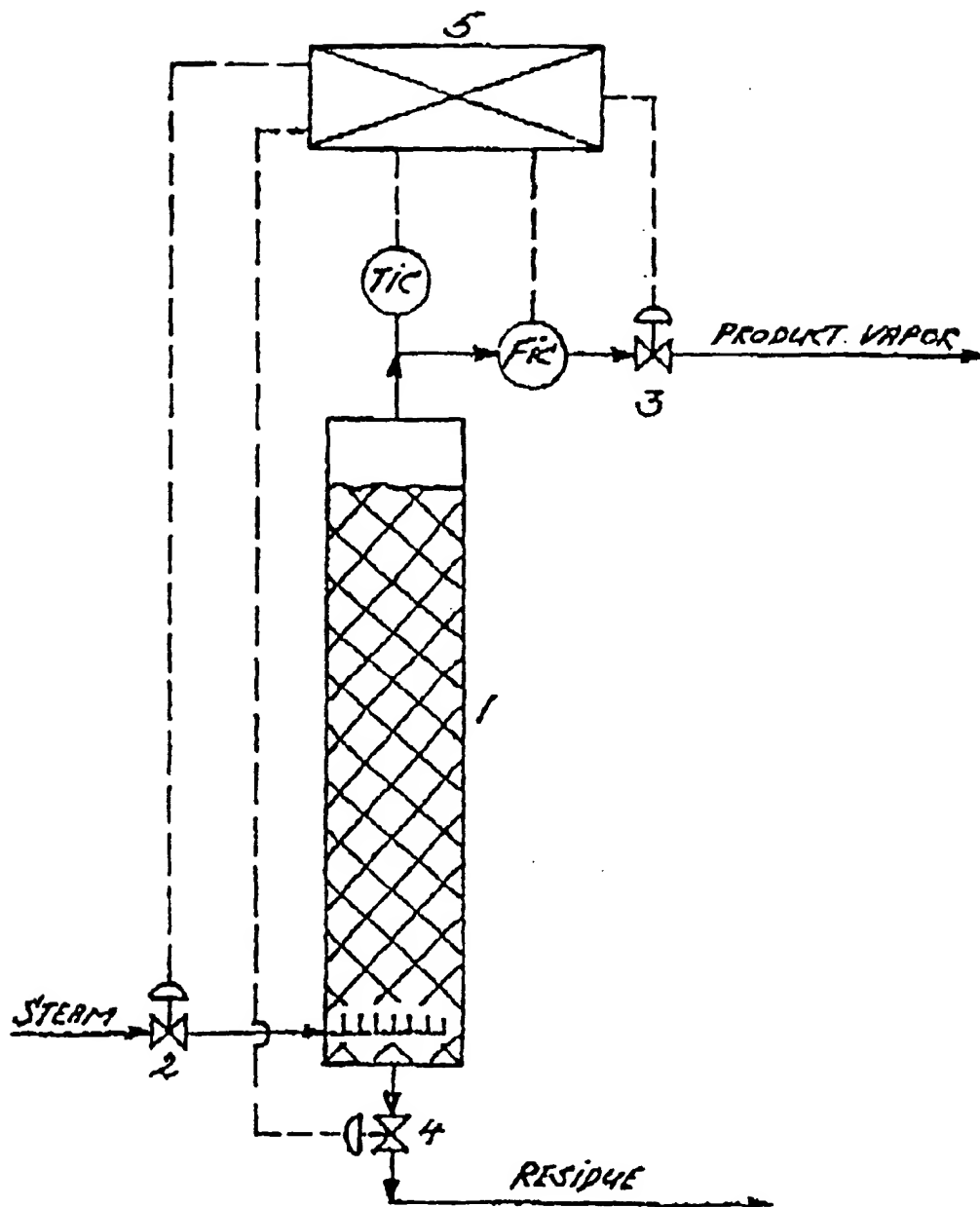


Figure 2 Schematic of the delayed decomposition process for the production of furfural.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/ZA 00/00024

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07D307/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 81 00407 A (BERTIN & CIE.) 19 February 1981 (1981-02-19) claims 1-30	1-13
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A	US 4 533 743 A (D. J. MEDEIROS, M. B. BURNETT) 6 August 1985 (1985-08-06) claims 1-13	1-6
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

27 June 2000

Date of mailing of the international search report

06/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
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Authorized officer

Herz, C

INTERNATIONAL SEARCH REPORT

International Application No

PCT/ZA 00/00024

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DATABASE WPI Week 8648 Derwent Publications Ltd., London, GB; AN 1986-317829 XP002141089 & SU 1 225 841 A (KRASD. POLY.), 23 April 1986 (1986-04-23) abstract -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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XP-002141089

AN - 1986-317829 [48]
AP - SU19843816523 19841121
CPY - KVM-I-R
DC - M24
FS - CPI
IC - C21B13/00 ; C22B1/00
IN - GLUSHAK A M; GUBIN G V; TSYURYUPA A D
MC - M24-A01A
PA - (KVM-I-R) KRIV MINE ORE INST
PN - SU1225867 A 19860423 DW198648 003pp
PR - SU19843816523 19841121
XA - C1986-137742
XIC - C21B-013/00 ; C22B-001/00
AB - SU1225867 The process consists of loading the material, heating, reducing the material to magnetite with a solid and/or gaseous reducing agent and discharging the prod.
- The firing process takes place until complete redn. to magnetite of the ore fraction of greater than 10mm is obtd. The final prod. of the firing, when it is discharged into the cooler, is treated with a gas-steam-air mixt. contg. 1-5% of O₂.
- ADVANTAGE - The concn. of magnetite in the fired prod. obtd. from the redn. of lump iron-contg. materials is increased.
- In an example, the degree of redn. to magnetite of the greater and less than 10mm fractions was 99 and 100% respectively. Bul.15/23.4.86 (3pp Dwg.No 0/0)
IW - REDUCE FIRE LUMP IRON CONTAIN MATERIAL COOLING FINAL PRODUCT GAS STEAM AIR MIXTURE
IKW - REDUCE FIRE LUMP IRON CONTAIN MATERIAL COOLING FINAL PRODUCT GAS STEAM AIR MIXTURE
INW - GLUSHAK A M; GUBIN G V; TSYURYUPA A D
NC - 001
OPD - 1984-11-21
ORD - 1986-04-23
PAW - (KVM-I-R) KRIV MINE ORE INST
TI - Reducing-firing of lump iron-contg. materials - involves cooling of final prod. with gas-steam-air mixt.